D4.2

Report on the first completed master cycle

skillbill

SKILL TO BOOST INNOVATION & PROFESSIONAL FULFILLMENT IN A SUSTAINABLE ECONOMY

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Executive Summary

This deliverable reports on the activities performed in WP4 of SKILLBILL to set-up the master program “European Specialization School in Sustainable Energy”. Each section focuses on the activities performed in a specific task, and a final section will analyse the master outcomes with particular reference to results of the students’ questionnaires.

The aim of this WP is to create the required network and infrastructures to educate the professionals who will lead the energy transition towards carbon-neutrality. In particular, the WP aims at creating a permanent educational program on RES at European level characterized by unique combination of in-depth knowledge of the technologies and of all the social, environmental, and economic implications of the said transition. The content and format are further relevant in the adoption and implementation of the Net-Zero Industry Act, which will require Member States to establish Net-Zeto Industry Academies. The International Specialization School developed under SKILLBILL could provide valuable input for the learning material that will be conceived for the Academies.

The title of the present deliverable - as stated in the Grant Agreement - is “Report on the first completed master cycle” but, actually, during the project two cycles of the master were lunched and the second is going to be completed soon. Thus, the deliverable will report the figures and results of both cycles.

The relevant outcomes of the WP are summarized below:

- Master program and syllabus launched in May 2023;
- 16 students enrolled to the first edition. All working students, in line with the SKILLBILL mission;
- Lessons of the first cycle started on February 2024 and completed in February 2025;
- Virtual Reality (VR) environments ready;
- More than 60 Students enrolled in the second edition.
- Second edition of the master launched in October 2024 and lessons are going to be completed in August 2025.

1. Task 4.1 Administrative organization

The objective of this task is to define and complete all the administrative procedures needed to activate the international master course.

All 4 academic partners (UNITUS, UU, USE, MET) actively contributed to the administrative organization of the program from the beginning of the project (September 2022) to December 2023. This was lasting longer than expected due to the onset of critical differences in the procedures in the different Universities. Specifically, Utrecht University cannot administer 60 ECTSs master programs whereas UNITUS required that the duration of the master is below 12 months. This also led to few modifications with respect to the envisaged pathway. Administrative organization is detailed in the program syllabus (Deliverable D4.1) and briefly summarized below:

- The official name of the Master is “European Specialization School in Sustainable Energy”;
- The program management board has been established and is composed by Prof. Andrea Luigi Facci (University of Tuscia), serving also as a director of the Master; Prof. David

Sanchez (University of Seville); Prof. Mona Roman (Metropolia University of Helsinki); Prof. Javanshir Fouladvand (University of Utrecht);

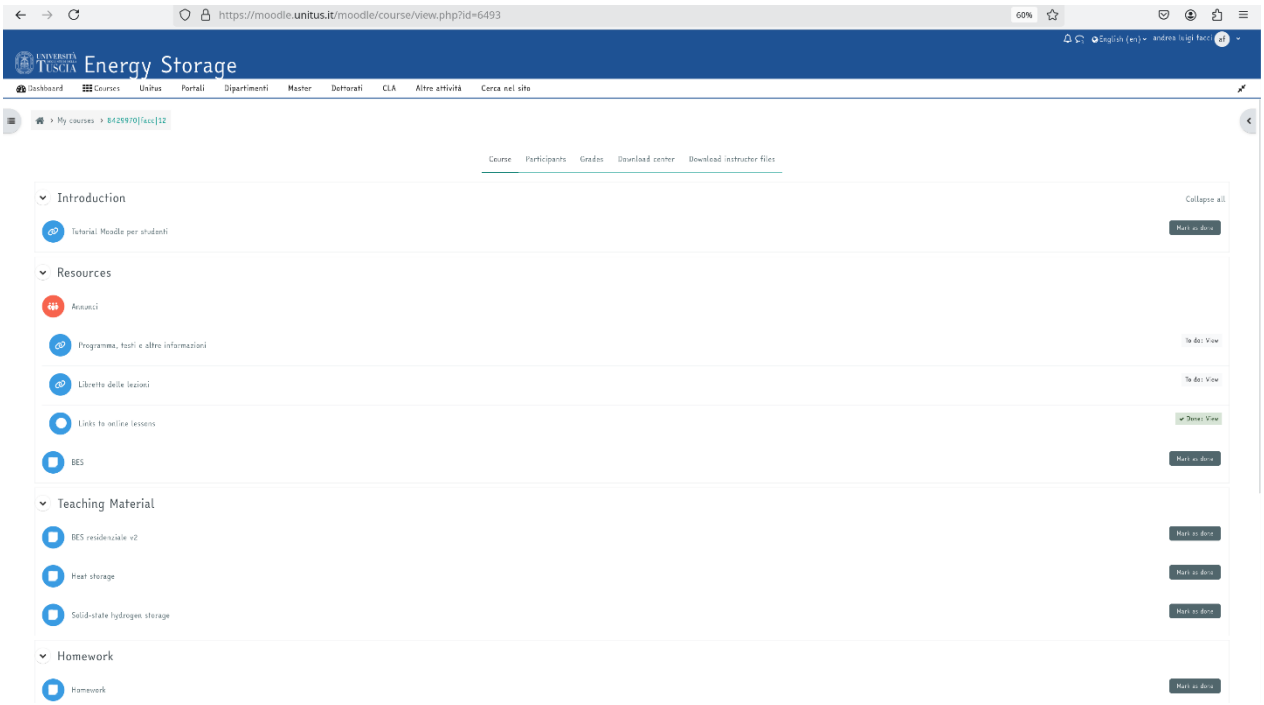
- The master degree title will be awarded by UNITUS, with MET, USE, UU officially supporting the organization of the program as well as the teaching activities. UNITUS will award the title of “First Level Master” to the students that successfully complete the whole program. It is a legally valid Higher Education Title equivalent to an EQF Level 7 degree. Certificates of attendance can be awarded by each venue to the students that successfully take single modules;
- The legal duration of the program will be 1 year for a total of 60 ECTSs (of which 48 from courses and 12 of final project). We note that the grant agreement foresees a legal duration of 2 years for the same ECTSs. However, regulations by UNITUS set a maximum duration of 12 months for 60 ECTS programs. This gave the opportunity to administer the program for two consecutive cycles withing the SKILLBILL duration. This, in turn, will allow: (a) reaching a potentially larger number of students; (b) improving the program after the first cycle. Educational objectives are not varied with respect to the grant agreement, as they are expressed in terms of ECTSs;
- The enrolled students should at least have a bachelor (entry level requirement 180 ECTSs), possibly in engineering or physics but also economics, mathematics, chemistry and physics are accepted. The board of the program can exceptionally accept also other bachelor's degrees following an analysis of the candidate’s CV;
- All the professors have been appointed by UNITUS, and they have been granted access to the Moodle platform of the program and to the UNITUS didactic management platform. Professors for the second edition of the program were appointed during the month of September 2024.

2. Task 4.2: Infrastructure equipment

The objective of the task is to provide all the infrastructure necessary to support the master activities including classrooms, laboratories, the VR hardware and software, and the platform to broadcast the lessons and to allow the interaction between students and teachers. This activity was completed within the first year of the project and reviewed before the second edition of the program. The most relevant outcomes of this task are listed below:

- The Moodle platform, hosted at UNITUS infrastructure (**moodle.unitus.it**), has been selected to broadcast the lessons and to provide a virtual space to host all the teaching material and allow the interaction between the teachers and the students. Pages for all modules have been created and all the teachers have been trained to interact with the platform. The platform has been updated in September 2024 according to the syllabus modifications for the second edition of the Master (See**Figure 1: Example of Moodle platform page** Figure 1 for example of the Moodle platform). The Moodle platform proved effective to deliver the teaching material and to allow student-teacher interactions;
- All Universities committed to make available a classroom and/or a laboratory equipped with standard webcam and microphone necessary to live broadcasting and with available space for VR activities;
- VR equipment (glasses, PC and camera) has been selected after interaction between MET (task leader) and the other universities. This equipment (specifically Meta Quest 3 512Ge visors) has been acquired by all Universities;
- MET implemented the virtual environment and trained all the teachers on its usage.

Figure 1: Example of Moodle platform page



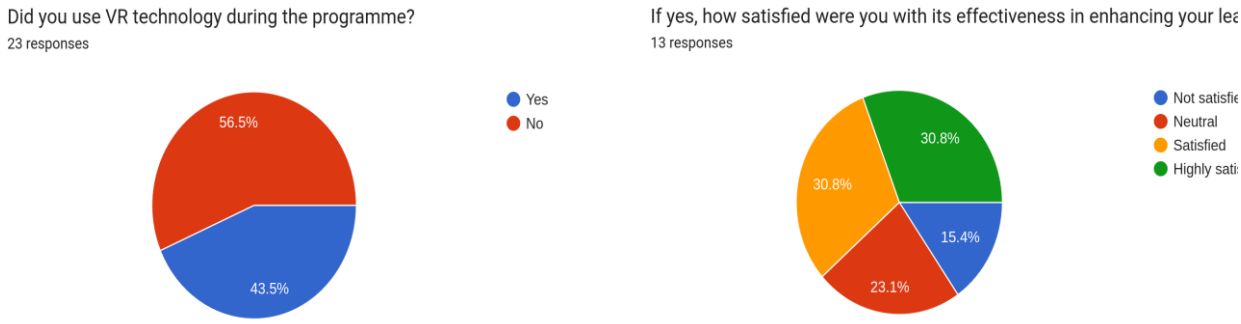
3. Task 4.3: Content design

The objective of this activity is to design and implement the VR content to support remote practical activities of the master allowing students that cannot attend in person to have an immersive experience of the experimental/practical activity. This activity has been completed within the first 24 months of the project and successfully delivered the teaching material to the students. Specifically:

- The modules that require Virtual Reality tools have been identified (Road transport, Renewable Heat Technologies, Sustainable Heat in Built Environment, Energy Storage) and reported in **D4.1**;
- All the Universities designed the practical activities to be represented through VR and provided the necessary material to MET (Videos, pictures, and textual descriptions);
- MET implemented the VR content that consists of 3D-modeled virtual environments, containing interactive objects and simulations related to the experiment for all the relevant modules. In total, 4 different VR simulations were implemented. The content for each simulation was designed based on the knowledge gained from the teachers of the module in question. Some simulations are planned only for a single module, and some are usable in multiple modules. The simulations are: Ground Heat System Setup and Connection Trainer, Molten Carbonate Fuel Cell Maintenance Trainer, Vehicle Power Generation System Trainer and Built Home Environment IoT Data Trainer. Guidance for installation and use was created by MET, and training of teachers and students will be performed in the next months.

The effectiveness of the VR tools to support the teaching activities, and in particular practical and lab activities has been assessed through students' questionnaires (see Figure 2 for results). As reported in Figure 2 more than 40% of the active students used VR tools and more than 60% of them is highly satisfied or satisfied, with only 15% not satisfied.

Figure 2: Assessment of VR usage satisfaction



4. Task 4.4: Didactic organization

The objective of this task is to define the didactic organization of the MSc in terms of syllabus, schedule, and lecturers. This was initially accomplished during the first year of the project and reported in Deliverable D4.1, with the Master syllabus that reports detailed programs, teaching methodologies and verification methods for each module. Table 1 reports the modules identified for the first master edition for each term and pillar.

Table 1: Organization of courses and lessons (1st edition)

	Renewable and Sustainable fuels	***Renewable and Sustainable Heat***		***Renewable and Sustainable Electricity***		***Sustainable Mobility***	***Sustainability and Circular Economy***		***System integration, energy management, storage and efficiency***
Term 1	**Biofuels**			Variable Renewable Energy Technologies	Dispatchable Renewable Energy Technologies				**Energy Management**
Term 2		**Renewable heat technologies**	Sustainable heat in built environment			Air transport	**Sustainability in the context of transitions**	Circular Economy	
Term 3	Waste to Fuels	Water energy nexus		**Introduction to the power grid and market of electricity**		**Road transport**			Energy Storage
Term 4	Power to X	Industrial renewable heat				Maritime transport			Multi-energy systems

After completing the first edition of the master the syllabus has been revised according to the students and teachers feedbacks. The most critical aspect was related to the difficulties of working students to actively participate to lessons, even online. Recognizing that working students are the most important target for the program, the board implemented several actions to facilitate their success:

- Reduction of the synchronous teaching from 6 hours per ECTS to 3 hours per ECTS (i.e. 18 hours per module) providing self-studying material to complement the reduction of teaching hours. The self-study material is equivalent to 18 hours of lessons.
- All lessons must be recorded to allow the students to access them according to their working time.

Recorded lessons and self-study material are also useful to facilitate the reproducibility of the program after the project end and can be considered a valuable outcome of the project.

Moreover, the syllabus has been slightly modified as reported in Table 2.

Table 2: Organization of courses and lessons (2nd edition)

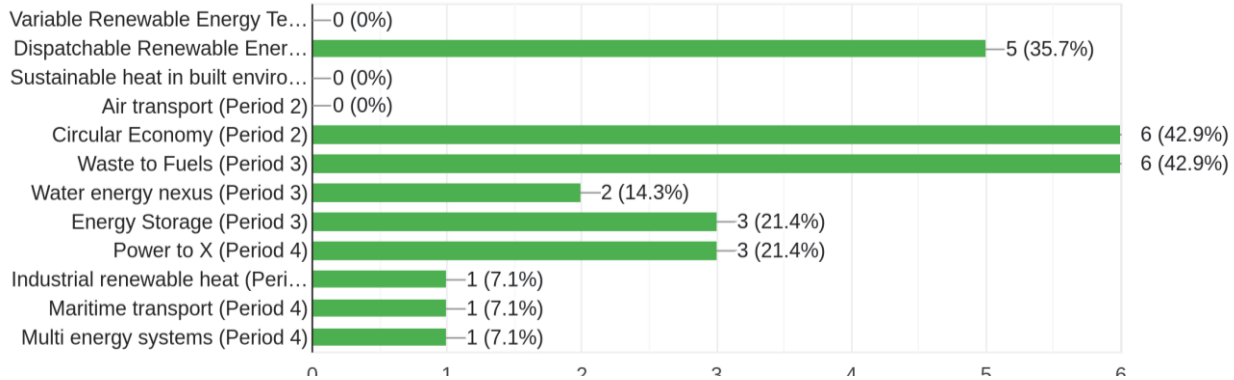
	Renewable and Sustainable fuels	***Renewable and Sustainable Heat***		***Renewable and Sustainable Electricity***	***Sustainable Mobility***	***Sustainability and Circular Economy***	***System integration, energy management, storage and efficiency***	
Term 1	Waste to Fuels	Water energy nexus		**Introduction to the power grid and market of electricity**	**Road transport**			
Term 2	Power to X	Industrial renewable heat		Dispatchable Renewable Energy Technologies		**LCA**	**Energy Management**	Energy Storage
Term 3	**Biofuels**			Variable Renewable Energy Technologies		**Sustainability in the context of transitions**		
Term 4		**Renewable heat technologies**	Sustainable heat in built environment		Air transport and Maritime transport	Circular Economy	Multi energy systems	

5. Task 4.5: Master delivery to students

The objective of this task is to deliver all teaching activities as well as assessment of the learning objectives related to the master program.

The 28th of June 2023 (act registered the 30th of June) the Academic Senate of UNITUS has decreed the establishment and activation of the Master achieving the **Milestone 5 "Master launched"** and the lessons of the first edition started on February, 19th 2024. A total of 16 students were enrolled to the first edition.

Figure 3: Study plans for the first edition of the master

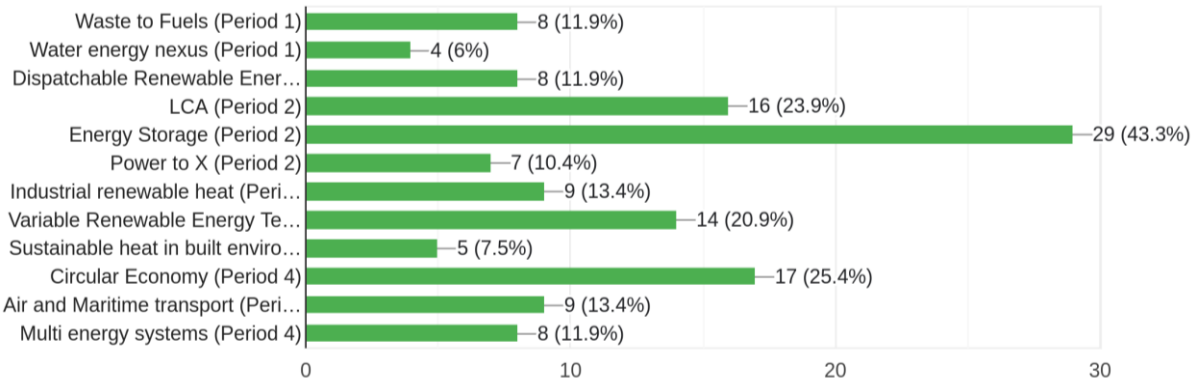


The courses of Industrial renewable heat, Maritime transport, multi-energy systems, sustainable heat in the built environment, variable renewable energy sources, air transport, and water energy nexus were selected by less than 3 students (see Figure 3). Therefore, these courses were not administered for the first master edition. As a consequence, a total of 11 courses were administered during the first edition of the Master, including 6 compulsory courses and 5 electives (circular economy, dispatchable renewable energy sources, waste to fuels, Energy storage and power to X). Lessons were completed at the end of February 2025.

The second edition of the master started on September 2024, slightly overlapping the first edition in order to allow completing the teaching activities within the project duration. More than 60 students submitted the enrolment application to the master and were admitted to the program reaching more than 75 students involved during the SKILLBILL project duration. On the one end this indicates that a significant training demand in the field of energy transition exists. On the other hand, it fosters the future sustainability of the program beyond the project duration. In fact, preliminary cost analysis demonstrated that between 30 and 50 students will secure the financial sustainability of the master. Notably the Master students originate from more than 20 countries including several developing regions (e.g. Marocco, Pakistan, Angeria, Tunisia) showing that Emerging economies are willing to undergo energy transition and that programs such as the European Specialization School in Sustainable Energy might provide guidance and opportunities to developing countries.

Due to the larger number of students compared to the first edition all elective modules have been selected by at least 4 students (see Figure 4). Therefore, all courses were administered for a total of 18 courses.

Figure 4: Study plans for the second edition of the master



Lessons are going to be completed during the month of August 2025.

6. Analysis of Master results and feedbacks.

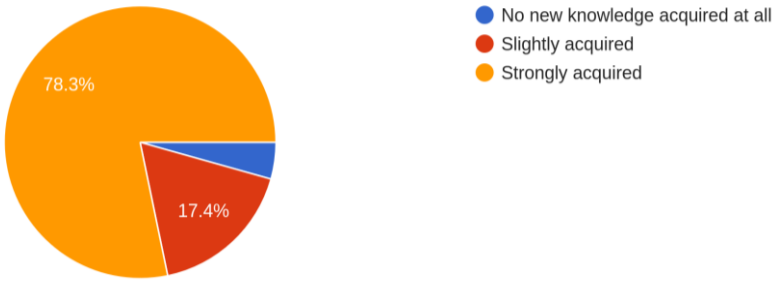
The board of the master continuously monitored the progresses and the effectiveness of the teaching activities and of the program organization by direct contact with the students and the teachers. For a more structured analysis of the program outcomes the board relies on the questionnaires fille by the students at the end of the program. A thorough analysis of the questionnaires is reported in D-6.4. However, here we briefly analyze the questions that are useful to assess the quality of the program activities and to design the future editions of the Master.

6.1 Impact of the program to the students' skills

The impact of the program on the students' skills is evaluated through the questions: (I) Did you acquire new knowledge and skills related to RES through this programme?; (II) Are you applying the skills and knowledge gained through the Master in your professional or academic life?; (III) Do you feel more proficient in solving real-world problems related to renewable energy sources (RES), as a result of the Master? These questions allow assessing whether the selection of the Master topics is correct, meets the students' expectation, and can be replicated for future editions of the program.

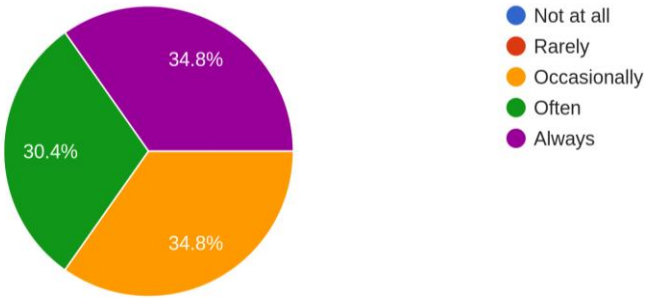
The first question (Did you acquire new knowledge and skills related to RES through this programme?) received 95% positive feedback (See figure 5), notably with 78% of the students that strongly acquired new skills.

Figure 5: Responses to the question: Did you acquire new knowledge and skills related to RES through this programme?



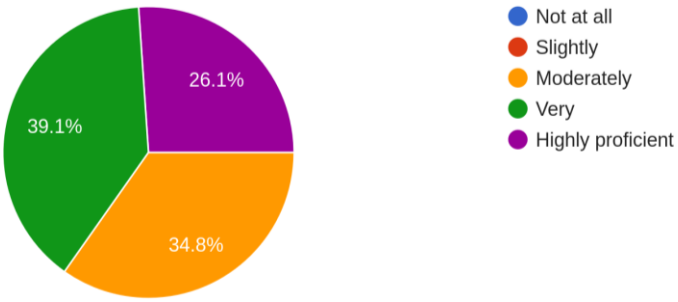
Notably, 100% of the students is applying the knowledge acquired during the master in their professional life, with more than 65% of them that applies such a knowledge always or often (See Figure 6).

Figure 6: Responses to the question: Are you applying the skills and knowledge gained through the Master in your professional or academic life?



As a result of the previous responses all the students feels more proficient in solving real-world problems related to renewable energy sources (RES) (See Figure 7), with more than 60% of the students feeling at least very proficient.

Figure 7: Do you feel more proficient in solving real-world problems related to renewable energy sources (RES), as a result of the Master?



To summarize, the analysis of these questions shows that the master had an excellent impact on the students' skills thanks to the selection of the topics including in-depth technical aspects as well as transversal subjects, such as social aspects related to the energy transition and economics of renewable energy. Therefore, the program syllabus is solid and can be substantially replicated for future editions of the master.

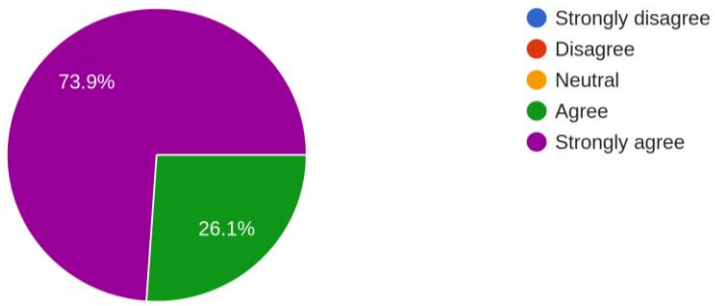
6.2 Access to education

One of the objectives of the program is to be accessible to students with different backgrounds, ages, gender and social position. This ability is evaluated through the questions: (I) Do you agree that the programme provided equal access and opportunities for students from various backgrounds?; (II) Were you satisfied with the flexibility of the Master?; (III) Do you agree that the Master is accessible to individuals of all genders and age groups?; and (IV) Do you agree that the programme is accessible to individuals from various backgrounds, considering factors such as socioeconomic status, educational background, and cultural differences?.

Figure 8 to 11 show that all these questions received absolutely positive feedbacks demonstrating that the master program organization gives access to higher education in sustainable energy to people from different cultural backgrounds, gender, social and economic conditions.

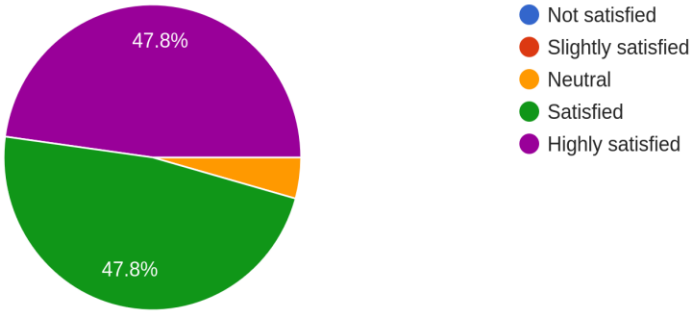
Notably, the results reported in Figure 8 demonstrate that teaching methodologies implemented in the program allows accessing higher education to students coming from different educational backgrounds (e.g. engineers, scientists, economists, social scientists). This is an evolution of traditional master programs in energy engineering that require specialistic engineering backgrounds to succeed thus limiting the access to new knowledge. This is further supported by Figure 11, that considers also socio-economic status and culture.

Figure 8: Responses to the question: Do you agree that the programme provided equal access and opportunities for students from various backgrounds?



Flexible teaching methodologies including time-independent teaching, self-study material, recorded lessons, usage of homework to evaluate the learning objectives have been particularly appreciated by the students (See Figure 9). In particular this effort allowed working students and people from different countries, therefore with different habits and schedules, to effectively participate to the master activities.

Figure 9: Responses to the question: Were you satisfied with the flexibility of the Master?



The results of Figure 10 are particularly relevant to the achievement of the SKILLBILL's objective to reduce the gender gap in STEMs: all participants reported that the program is equally accessible to individuals from different gender groups. Moreover, in Figure 11 it is highlighted that the program is highly accessible to people from different cultural backgrounds, gender, social and economic conditions.

Figure 10: Responses to the question: Do you agree that the Master is accessible to individuals of all genders and age groups?

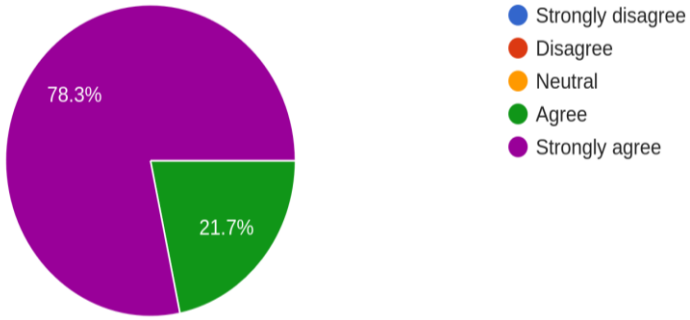
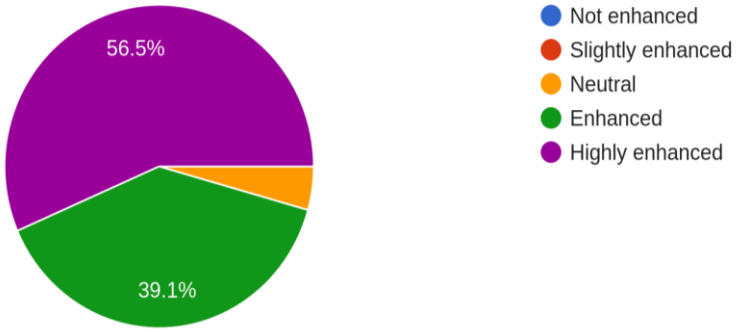


Figure 11: Responses to the question: Do you agree that the programme is accessible to individuals from various backgrounds, considering factors such as socioeconomic status, educational background, and cultural differences?



6.3 Effects of Universities Collaboration

One of the distinctive features of the Master program “European Specialization School in Sustainable Energy” is the collaborative effort of 4 different Universities (University of Tuscia, Siviglia University, Utrecht University and Metropolia Universty of Helsinky). On the one hand this positively exposed the students to an international environment characterized by different point of views and cultures thus facilitating cultural integration and critical thinking. On the other hand, each University and country has different teaching traditions and methodologies. Therefore, it also fostered the risk of confusing students in particular with respect to the methodologies to assess the learning objectives. The board dedicated a significant effort to avoid this risk, while taking advantage from international environment crated by the collaboration between universities.

The result of this effort is reported in Figures 12 and 13, that show the replies to the questions: (I) Has the collaboration between universities enhanced the quality of the Master?, and (II) Do you think the collaboration between universities has effectively enriched your learning experience in the programme?: Overall more than 90% of the students found that the collaboration between universities has been positive and enhanced the quality of the master program. In particular, such collaboration gave them access to different teaching methodologies, cultures, and points of view without creating confusion to the students.

Figure 12: Responses to the question: Has the collaboration between universities enhanced the quality of the Master?

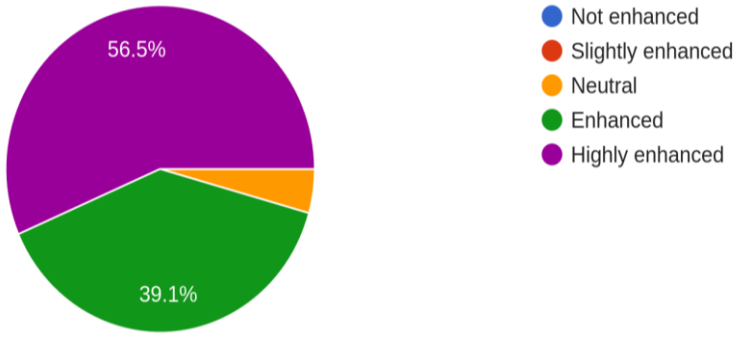
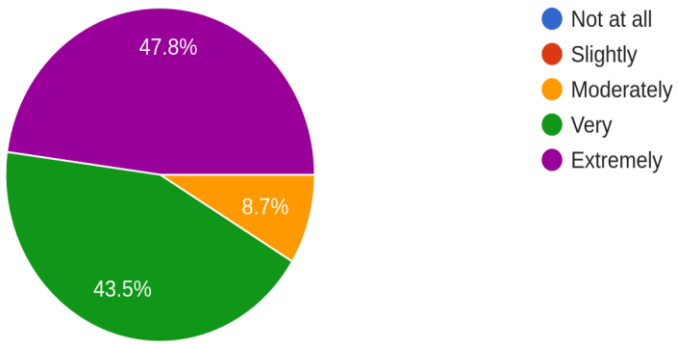


Figure 13: Responses to the question: Do you think the collaboration between universities has effectively enriched your learning experience in the programme?



These positive results foster the future continuation of the program beyond the project duration, fruitfully exploiting the collaboration between the same universities and, eventually, expanding the collaboration to other universities and/or research institutions.

The project

SKILLBILL's overall objective is to develop a large and strong foundation for the growth and acceleration of renewable energy's deployment, thanks to engaging with stakeholders of the whole chain, diffusing scientific culture and skilling multi-level workers. The basic idea underling the project is that the knowledge should be diffused at several different levels and qualitatively appropriate both to train the adequate number of workers and to increase RES awareness and to reach a more social and inclusive Europe. The project aims at creating several pathways to induce target groups to get interested or involved in RES besides their initial level of education and their working position. It's important, beside the creation of instruments for the upskilling and reskilling of workers, technician and designers, to have awareness modules for unspecific public in order to fight against lack of information, bad quality material, gender gap and the phenomenon of functional illiteracy: it is widely documented that lifelong suitable learning process is the fundamental driver to support the development, maintenance and update of skills. Thus, SKILLBILL proposes concrete actions to accelerate the deployment of renewable energy at different levels to analyse and involve all the interested parts in open discussion using adequate language; create several different pathways to increase skills after having mapped knowledge gap and without gender prejudice; develop and implement innovative learning method; and evaluate the work performed.

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